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Third Semiannual Progress Report

on

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Design Study for Zodiacal - Light Observations from an Orbiting Solar Observatory

1. General Information

This project has now been in existence for 18 months. During the last six months, progress was made with the construction of a prototype unit of of the instrument, including electronic components in breadboard form.

There has been no change in the general objective of this study, which consists of the design and testing of a prototype for an OSO-borne instrument for zodiacal-light observations at elongations between 3^o and 15^o from the sun, including readings of polarization in various parts of the spectrum.

2. Work Accomplished in the Past Six Months

Based on our experience with the breadboard model built in the first year, work has gotten underway on the prototype.

A second set of optical parts has been received, after much delay. Teflon-cushioned cells made of Invar steel to hold these parts (ultimately to be made of fused quartz) have been designed and constructed.

A design for the triple knife-edge assembly to shade the entrance aperture of the telescope has been completed. We are waiting for delivery of those parts of this assembly which are made by electro-forming.

The design of our new building (we started moving in on December 28, 1965) presented an opportunity for creating a special optical testing facility for this and similar projects. Almost the entire length of the new building has been provided with knock-out panels in wall partitions, so that a horizontal beam of sunlight can be projected through the building over a distance of 200 feet. If necessary, this beam can be enclosed in a light-tight, dust free enclosure, which could even consist of an evacuated tube. At the end of this beam is a darkroom which is 50 feet long to accommodate the satellite package, and, at its very end, a "black body" to remove, without appreciable reflection, that portion of the beam which is not intercepted by the instrument. This facility will provide us shortly with an optical environment which closely simulates that actually encountered by the satellite, i.e., full sunlight against a virtually black background, or against a simulated zodiacal light region as described in our Second Semiannual Progress Report. For the time being we shall use somewhat less than half of the available path length. A heliostat which directs the beam of sunlight horizontally has been constructed, using 16" and 12" flats which were available in the department.

Considerable preparatory work has also been done in the report period on digital encoding for the telemetry of the shaft and slide positions of the various components of the package. We designed a cyclic gray code with appropriate non-ambiguous command read-out circuitry, as well as a suitable converter to the binary coded decimal format.

Two Ascop photomultiplier tubes have been received and tested. Performance tests on these tubes have been accomplished with excellent results. There is no doubt that both of these tubes will be acceptable for the experiment, even though one of them is vastly superior to the other--a common occurrence with photomultiplier tubes. One disappointment is that the power supplies, which are integrated with their respective tubes in the same housing, superimpose a pulse upon the signal. However, this pulse is much larger than the individual signal pulses, so that for pulse counting read-out the power-supply pulse can be removed from the data by means of a simple discriminator circuit. If we should use analog/digital conversion circuitry, these pulses are even less bothersome, since they do not contribute to the d.c. level of the photomultiplier output.

During the report period an arrangement with C. G. Electronics Division of Gulton in Albuquerque was concluded, under which they have undertaken to design electronic read-out circuitry for the photomultiplier tubes under our direction, and to furnish us with working models in the breadboard stage. They are billing us monthly on a time-and-materials basis. Work on this project began on November 16, 1965, and the first breadboard has been delivered in the meantime. It contains an analog/digital converter with automatic ranging over four decades for d.c. input current levels from 10^{-10} to 10^{-6} amperes from an infinite impedance source, with an accuracy of 1%. While this relatively ambitious goal has not yet been fully attained, we are gaining valuable experience with this unit.

3. Plans for the Next Phase

Most of the next six months will consist of the remaining mechanical construction of the prototype, of the assembly of the optical parts and of the electronic breadboards. Integration of the mechanical, optical and electronic components will follow, as well as actual testing of the unit in the "space" darkroom described above. An environmental test phase should follow, but it is very doubtful that we shall be able to accomplish much in this regard before July 1, 1966. An application has been made to NASA for additional funds to permit the purchase of some environmental test equipment, but notification is still pending.

4. Personnel and Expenditures

The work during the report period has been accomplished by John W. McLean, Instrument Maker, Robert Bogue and Larry Braley, machinists, and by Victor H. Regener, project director. Beginning January 1, 1966, Mr. Arthur Kimmell will work as electronics technician.

Remaining funds are expected to last until July 1, 1966, the second anniversary of the grant.